CLAIMS

We claim:

1. A process for removing a metallized surface from a workpiece, wherein a kinetic removal mechanism for removal of said metallized surface is characterized by a formation step for formation of a removable surface film surface and an abrasive step for removal of said film, said process comprising:

causing said workpiece to contact a polishing member while effecting relative motion between said workpiece and said polishing member; and

causing a polishing solution having less than 1 wt % of a polishing abrasive to be distributed at a contact area between said workpiece and said polishing member so that said abrasive step is a rate-determining step of said removal mechanism.

2. The process of claim 1, wherein said causing comprises supplying said polishing solution to said contact area through a plurality of pores formed in said polishing member.

3. The process of claim 1, wherein said causing comprises supplying said polishing solution to said contact area through at least one channel formed in said polishing member.

4. The process of claim 2, wherein said causing further comprises supplying said polishing solution to said polishing member through at least one bore formed in a platen connected to said polishing member.

5. The process of claim 3, wherein said causing further comprises supplying said polishing solution to said polishing member through at least one bore formed in a platen connected to said polishing member, wherein said at least one bore is collinear with said at least one channel.

6. The process of claim 2, further comprising forming on said polishing surface a plurality of grooves that are configured to facilitate distribution of said polishing solution.

7. The process of claim 3, further comprising forming on said polishing surface a plurality of grooves that are configured to facilitate distribution of said polishing solution.

8. The process of claim 7, wherein said forming comprises forming said plurality of grooves so that said at least one channel intersects at least one of said plurality of grooves.

9. The process of claim 6, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

10. The process of claim 7, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

11. The process of claim 1, further comprising establishing a temperature at said contact area while said polishing solution is distributed to said contact area.

12. The process of claim 11, wherein said establishing comprises circulating a fluid having a predetermined temperature proximate a surface of said workpiece.

13. The process of claim 11, wherein said establishing comprises one of heating and cooling said polishing solution before said causing said polishing solution to be distributed to said contact area.

14. The process of claim 11, wherein said establishing comprises connecting a platen to said polishing surface, said platen being formed of a heat conductivity material through which a fluid having a predetermined temperature circulates.

15. The process of claim 1, further comprising forming on said polishing member a plurality of grooves that are configured to facilitate distribution of said polishing solution.

16. The process of claim 15, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

17. The process of claim 15, further comprising establishing a temperature at said contact area while said polishing solution is distributed to said contact area.

18. The process of claim 17, wherein said establishing comprises circulating a fluid having a predetermined temperature proximate a surface of said workpiece.

19. The process of claim 17, wherein said establishing comprises one of heating and cooling said polishing solution before said causing said polishing solution to be distributed to said contact area.

20. The process of claim 17, wherein said establishing comprises connecting a platen to said polishing surface, said platen being formed of a heat conductivity material through which a fluid having a predetermined temperature circulates.

21. The process of claim 1, wherein said causing said workpiece to contact a polishing member comprises causing said workpiece to contact a polishing member at a low down force pressure.

22. The process of claim 21, wherein said causing said workpiece to contact a polishing member at a low down force pressure comprises causing said workpiece to contact a polishing member at a pressure within a range of from about 0.10 psi to about 3.0 psi.

23. The process of claim 22, wherein said causing said workpiece to contact a polishing member at a low down force pressure comprises causing said workpiece to

contact a polishing member at a pressure within a range of from about 0.10 psi to about 1.0 psi.

24. A process for removing a metallized surface from a workpiece, wherein a kinetic removal mechanism for removal of said metallized surface is characterized by a formation step for formation of a removable surface film and an abrasive step for removal of said film, said process comprising:

pressing said workpiece against a polishing member while effecting relative motion between said workpiece and said polishing member;

causing a polishing solution having less than 1 wt % of a polishing abrasive to be distributed at a contact area between said workpiece and said polishing member; and

establishing a temperature at said contact area while said polishing solution is distributed to said contact area so that said abrasive step is a rate-determining step of said removal mechanism.

25. The process of claim 24, wherein said establishing a temperature comprises circulating a fluid having a predetermined temperature proximate a surface of said workpiece.

26. The process of claim 24, wherein said establishing a temperature comprises one of heating and cooling said polishing solution before said causing said polishing solution to be distributed to said contact area.

27. The process of claim 24, wherein said establishing a temperature comprises connecting a platen to said polishing member, said platen being formed of a heat conductivity material through which a fluid having a predetermined temperature circulates.

28. The process of claim 24, wherein said causing comprises supplying said polishing solution to said contact area through a plurality of pores formed in the polishing surface.

29. The process of claim 24, wherein said causing comprises supplying said polishing solution to said contact area through at least one channel formed in said polishing surface.

30. The process of claim 28, wherein said causing further comprises supplying said polishing solution to said polishing member through at least one bore formed in a platen connected to said polishing member.

31. The process of claim 29, wherein said causing further comprises supplying said polishing solution to said polishing member through at least one bore formed in a platen connected to said polishing member, wherein said at least one bore is collinear with said at least one channel.

32. The process of claim 28, further comprising forming on said polishing surface a plurality of grooves that are configured to facilitate distribution of said polishing solution.

33. The process of claim 29, further comprising forming on said polishing surface a plurality of grooves that are configured to facilitate distribution of said polishing solution.

34. The process of claim 33, wherein said forming comprises forming said plurality of grooves so that said at least one channel intersects at least one of said plurality of grooves.

35. The process of claim 32, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

36. The process of claim 33, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

37. An apparatus for removing a metallized surface from a workpiece, wherein a kinetic removal mechanism for removal of said metallized surface is characterized by a formation step for formation of a removable surface film and an abrasive step for removal of said surface film, and wherein said abrasive step is a rate-determining step of said removal mechanism, the apparatus comprising:

(a) a source of a polishing solution having less than 1 wt % of a polishing abrasive;

(b) a polishing member;

(c) a polishing solution delivery assembly configured to deliver said polishing solution to said polishing member;

(c) a workpiece carrier configured to carry said workpiece and to press said workpiece against said polishing member; and

(d) a drive assembly configured to effect relative motion between said workpiece and said polishing member.

38. The apparatus of claim 37, wherein said polishing member comprises pores through which said polishing solution flows.

39. The apparatus of claim 37, wherein said polishing pad comprises at least one channel through which said polishing solution flows.

40. The apparatus of claim 38, wherein said polishing solution delivery assembly comprises a platen having at least one bore in fluid communication with said source of said polishing solution.

41. The apparatus of claim 39, wherein said polishing solution delivery assembly comprises a platen having at least one bore which is in fluid communication with said source of said polishing solution and which is collinear with said at least one channel.

42. The apparatus of claim 38, wherein said polishing member comprises a polishing surface and a plurality of grooves formed on said polishing surface, and wherein said grooves are configured to facilitate distribution of the polishing solution on said polishing surface.

43. The apparatus of claim 39, wherein said polishing member comprises a polishing surface and a plurality of grooves formed on said polishing surface, and wherein said grooves are configured to facilitate distribution of the polishing solution on said polishing surface.

44. The apparatus of claim 43, wherein said at least one channel intersects at least one of said plurality of grooves.

45. The apparatus of claim 42, wherein said plurality of grooves comprises a plurality of first grooves configured in parallel relation and a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

46. The apparatus of claim 43, wherein said plurality of grooves comprises a plurality of first grooves configured in parallel relation and a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

47. The apparatus of claim 37, further comprising a temperature-control apparatus for regulating a temperature of said polishing solution from said source.

48. The apparatus of claim 37, wherein said workpiece carrier comprises a fluid having a predetermined temperature for regulating the temperature of the workpiece.

49. The apparatus of claim 40, wherein said platen comprises heat conductivity material and wherein a temperature of said platen is configured to be modified by a heat exchange fluid circulating therethrough.

50. The apparatus of claim 41, wherein said platen comprises heat conductivity material and wherein a temperature of said platen is configured to be modified by a heat exchange fluid circulating therethrough.

51. The apparatus of claim 37, wherein said relative motion comprises at least one of rotary, orbital and linear motion.

52. A process for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures, wherein the workpiece contacts a polishing member at a contact pressure, said process comprising:

causing a polishing solution to be distributed at a contact area between said workpiece and said polishing member so that a rate of removal of said copper surface is approximately proportional to said contact pressure within a range of contact pressures, wherein said range of contact pressures comprises a low-down force pressure.

53. The process of claim 52, wherein said causing said polishing solution to be distributed comprises supplying said polishing solution to said contact area through a plurality of pores formed in the polishing member.

54. The process of claim 52, wherein said causing said polishing solution to be distributed comprises supplying said polishing solution to said contact area through at least one channel formed in said polishing member.

55. The process of claim 53, wherein said causing further comprises supplying said polishing solution to said polishing member through at least one bore formed in a platen connected to said polishing member.

56. The process of claim 54, wherein said causing further comprises supplying said polishing solution to said polishing member through at least one bore formed in a platen connected to said polishing member, wherein said at least one bore is collinear with said at least one channel.

57. The process of claim 53, further comprising forming on said polishing member a plurality of grooves that are configured to facilitate distribution of said polishing solution.

58. The process of claim 54, further comprising forming on said polishing member a plurality of grooves that are configured to facilitate distribution of said polishing solution.

59. The process of claim 58, wherein said forming comprises forming said plurality of grooves so that said at least one channel intersects at least one of said plurality of grooves.

60. The process of claim 57, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

61. The process of claim 58, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

62. The process of claim 52, further comprising establishing a temperature at said contact area.

63. The process of claim 62, wherein said establishing comprises circulating a fluid having a predetermined temperature proximate a surface of said workpiece.

64. The process of claim 62, wherein said establishing comprises one of heating and cooling said polishing solution before said causing said polishing solution to be distributed to said contact area.

65. The process of claim 62, wherein said establishing comprises connecting a platen to said polishing member, said platen being formed of a heat conductivity material through which a fluid having a predetermined temperature circulates.

66. The process of claim 52, further comprising forming on said polishing member a plurality of grooves that are configured to facilitate distribution of said polishing solution.

67. The process of claim 66, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second

grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

68. The process of claim 66, further comprising establishing a temperature at said contact area.

69. The process of claim 68, wherein said establishing comprises circulating a fluid having a predetermined temperature proximate a surface of said workpiece.

70. The process of claim 68, wherein said establishing comprises one of heating and cooling said polishing solution before said causing said polishing solution to be distributed to said contact area.

71. The process of claim 68, wherein said establishing comprises connecting a platen to said polishing member, said platen being formed of a heat conductivity material through which a fluid having a predetermined temperature circulates.

72. The process of claim 52, wherein said process for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures comprises a process for removing a copper surface from a workpiece having damascene structures with minimum feature dimensions no greater than 0.18 microns.

73. The process of claim 52, wherein said process for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures comprises a process for removing a copper surface from a workpiece formed of low dielectric constant materials.

74. The process of claim 72, wherein said process for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures comprises a process for removing a copper surface from a workpiece formed of low dielectric constant materials.

75. The process of claim 52, wherein said polishing solution has less than 1 wt % of a polishing abrasive.

76. The process of claim 52, wherein said causing comprises causing a polishing solution to be distributed at a contact area between said workpiece and said polishing member so that a rate of removal of said copper surface is approximately proportional to said contact pressure within a range of contact pressures, wherein said range of contact pressures comprises a low down force pressure in a range of from about 0.10 psi to about 3.0 psi.

77. The process of claim 76, wherein said causing comprises causing a polishing solution to be distributed at a contact area between said workpiece and said polishing member so that a rate of removal of said copper surface is approximately proportional to said contact pressure within a range of contact pressures, wherein said range of contact pressures comprises a low down force pressure in a range of from about 0.10 psi to about 3.0 psi.

78. A process for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures, wherein the workpiece contacts a polishing member at a contact pressure, said process comprising:

causing a polishing solution having less than 1 wt % of a polishing abrasive to be distributed at a contact area between said workpiece and said polishing member so that a rate of removal of said copper surface is approximately proportional to said contact pressure within a range of contact pressures, wherein said range of contact pressures comprises a low down force pressure.

79. The process of claim 78, wherein said causing said polishing solution to be distributed comprises supplying said polishing solution to said contact area through a plurality of pores formed in the polishing member.

80. The process of claim 78, wherein said causing said polishing solution to be distributed comprises supplying said polishing solution to said contact area through at least one channel formed in said polishing member.

81. The process of claim 79, wherein said causing further comprise supplying said polishing solution to said polishing member through at least one bore formed in a platen connected to said polishing member.

82. The process of claim 80, wherein said causing further comprises supplying said polishing solution to said polishing member through at least one bore formed in a platen connected to said polishing member, wherein said at least one bore is collinear with said at least one channel.

83. The process of claim 79, further comprising forming on said polishing member a plurality of grooves that are configured to facilitate distribution of said polishing solution.

84. The process of claim 80, further comprising forming on said polishing member a plurality of grooves that are configured to facilitate distribution of said polishing solution.

85. The process of claim 84, wherein said forming comprises forming said plurality of grooves so that said at least one channel intersects at least one of said plurality of grooves.

86. The process of claim 83, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

87. The process of claim 84, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

88. The process of claim 78, further comprising establishing a temperature at said contact area.

89. The process of claim 88, wherein said establishing comprises circulating a fluid having a predetermined temperature proximate a surface of said workpiece.

90. The process of claim 88, wherein said establishing comprises one of heating and cooling said polishing solution before said causing said polishing solution to be distributed to said contact area.

91. The process of claim 88, wherein said establishing comprises connecting a platen to said polishing member, said platen being formed of a heat conductivity material through which a fluid having a predetermined temperature circulates.

92. The process of claim 78, further comprising forming on said polishing member a plurality of grooves that are configured to facilitate distribution of said polishing solution.

93. The process of claim 92, wherein said forming comprises forming a plurality of first grooves configured in parallel relation and forming a plurality of second

grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

94. The process of claim 92, further comprising establishing a temperature at said contact area.

95. The process of claim 94, wherein said establishing comprises circulating a fluid having a predetermined temperature proximate a surface of said workpiece.

96. The process of claim 94, wherein said establishing comprises one of heating and cooling said polishing solution before said causing said polishing solution to be distributed to said contact area.

97. The process of claim 94, wherein said establishing comprises connecting a platen to said polishing member, said platen being formed of a heat conductivity material through which a fluid having a predetermined temperature circulates.

98. The process of claim 78, wherein said process for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures comprises a process for removing a copper surface from a workpiece having damascene structures with minimum feature dimensions no greater than 0.18 microns.

99. The process of claim 78, wherein said process for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures comprises a process for removing a copper surface from a workpiece formed of low dielectric constant materials.

100. The process of claim 98, wherein said process for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures comprises a process for removing a copper surface from a workpiece formed of low dielectric constant materials.

101. The process of claim 78, wherein said causing comprises causing a polishing solution having less than 1 wt% of a polishing abrasive to be distributed at a

contact area between said workpiece and said polishing member so that a rate of removal of said copper surface is approximately proportional to said contact pressure within a range of contact pressures, wherein said range of contact pressures comprises a low down force pressure in a range of from about 0.10 psi to about 3.0 psi.

102. The process of claim 101, wherein said causing comprises causing a polishing solution having less than 1 wt% of a polishing abrasive to be distributed at a contact area between said workpiece and said polishing member so that a rate of removal of said copper surface is approximately proportional to said contact pressure within a range of contact pressures, wherein said range of contact pressures comprises a low down force pressure in a range of from about 0.10 psi to about 3.0 psi.

103. An apparatus for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures, the apparatus comprising:

(a) a source of a polishing solution;

(b) a polishing member;

(c) a workpiece carrier configured to carry said workpiece and to press said workpiece against said polishing member at a contact pressure;

(d) a drive assembly configured to effect relative motion between said workpiece and said polishing member; and

(e) a polishing solution distribution assembly configured to distribute said polishing solution at a contact area between said workpiece and said polishing member so that a rate of removal of said copper surface is approximately proportional to said contact pressure along a range of contact pressures, wherein said range of contact pressures comprises a low down force pressure.

104. The apparatus of claim 103, wherein said polishing member comprises pores through which said polishing solution flows.

105. The apparatus of claim 103, wherein said polishing member comprises at least one channel through which said polishing solution flows.

106. The apparatus of claim 104, wherein said polishing solution distribution assembly comprises a platen having at least one bore in fluid communication with said source of said polishing solution.

107. The apparatus of claim 105, wherein said polishing solution distribution assembly comprises a platen having at least one bore which is in fluid communication with said source of said polishing solution and which is collinear with said at least one channel.

108. The apparatus of claim 104, wherein said polishing member comprises a polishing surface and a plurality of grooves formed on said polishing surface, and wherein said grooves are configured to facilitate distribution of the polishing solution on said polishing surface.

109. The apparatus of claim 105, wherein said polishing member comprises a polishing surface and a plurality of grooves formed on said polishing surface, and wherein said grooves are configured to facilitate distribution of the polishing solution on said polishing surface.

110. The apparatus of claim 109, wherein said at least one channel intersects at least one of said plurality of grooves.

111. The apparatus of claim 108, wherein said plurality of grooves comprises a plurality of first grooves configured in parallel relation and a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

112. The apparatus of claim 109, wherein said plurality of grooves comprises a plurality of first grooves configured in parallel relation and a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

113. The apparatus of claim 103, further comprising a temperature-control apparatus for regulating a temperature of said polishing solution from said source.

114. The apparatus of claim 103, wherein said workpiece carrier comprises a fluid having a predetermined temperature for regulating the temperature of the workpiece.

115. The apparatus of claim 106, wherein said platen comprises heat conductivity material and wherein a temperature of said platen is configured to be modified by a heat exchange fluid circulating therethrough.

116. The apparatus of claim 107, wherein said platen comprises heat conductivity material and wherein a temperature of said platen is configured to be modified by a heat exchange fluid circulating therethrough.

117. The apparatus of claim 103, wherein said relative motion comprises at least one of rotary, orbital and linear motion.

118. The apparatus of claim 103, wherein said polishing solution comprises less than 1 wt % of polishing abrasives.

119. The apparatus of claim 103, wherein said workpiece comprises minimum feature dimensions no greater than 0.18 microns.

120. The apparatus of claim 103, wherein said workpiece is formed of low dielectric constant materials.

121. The apparatus of claim 119, wherein said workpiece is formed of low dielectric constant materials.

122. The apparatus of claim 103, wherein said low down force pressure is within the range of from about 0.10 psi to about 3.0 psi.

123. The apparatus of claim 122, wherein said low down force pressure is within the range of from about 0.10 psi to about 3.0 psi.

124. An apparatus for removing a copper surface from a workpiece having at least one of single damascene structures and dual damascene structures, the apparatus comprising:

(a) a source of a polishing solution having less than 1 wt % of a polishing abrasive;

(b) a polishing member;

(c) a workpiece carrier configured to carry said workpiece and to press said workpiece against said polishing member at a contact pressure;

(d) a drive assembly configured to effect relative motion between said workpiece and said polishing member; and

(e) a polishing solution distribution assembly configured to distribute said polishing solution at a contact area between said workpiece and said polishing member so that a rate of removal of said copper surface is approximately proportional to said contact pressure along a range of contact pressures, wherein said range of contact pressures comprises a low down force pressure.

125. The apparatus of claim 124, wherein said polishing member comprises pores through which said polishing solution flows.

126. The apparatus of claim 124, wherein said polishing member comprises at least one channel through which said polishing solution flows.

127. The apparatus of claim 125, wherein said polishing solution distribution assembly comprises a platen having at least one bore in fluid communication with said source of said polishing solution.

128. The apparatus of claim 126, wherein said polishing solution distribution assembly comprises a platen having at least one bore which is in fluid communication with said source of said polishing solution and which is collinear with said at least one channel.

129. The apparatus of claim 125, wherein said polishing member comprises a polishing surface and a plurality of grooves formed on said polishing surface, and wherein said grooves are configured to facilitate distribution of the polishing solution on said polishing surface.

130. The apparatus of claim 126, wherein said polishing member comprises a polishing surface and a plurality of grooves formed on said polishing surface, and wherein said grooves are configured to facilitate distribution of the polishing solution on said polishing surface.

131. The apparatus of claim 130, wherein said at least one channel intersects at least one of said plurality of grooves.

132. The apparatus of claim 129, wherein said plurality of grooves comprises a plurality of first grooves configured in parallel relation and a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

133. The apparatus of claim 130, wherein said plurality of grooves comprises a plurality of first grooves configured in parallel relation and a plurality of second grooves configured in parallel relation, and wherein said plurality of first grooves is configured perpendicular to said plurality of second grooves.

134. The apparatus of claim 124, further comprising a temperature-control apparatus for regulating a temperature of said polishing solution from said source.

135. The apparatus of claim 124, wherein said workpiece carrier comprises a fluid having a predetermined temperature for regulating the temperature of the workpiece.

136. The apparatus of claim 127, wherein said platen comprises heat conductivity material and wherein a temperature of said platen is configured to be modified by a heat exchange fluid circulating therethrough.

137. The apparatus of claim 128, wherein said platen comprises heat conductivity material and wherein a temperature of said platen is configured to be modified by a heat exchange fluid circulating therethrough.

138. The apparatus of claim 124, wherein said relative motion comprises at least one of rotary, orbital and linear motion.

139. The apparatus of claim 124, wherein said workpiece comprises minimum feature dimensions no greater than 0.18 microns.

140. The apparatus of claim 124, wherein said workpiece is formed of low dielectric constant materials.

141. The apparatus of claim 139, wherein said workpiece is formed of low dielectric constant materials.

142. The apparatus of claim 124, wherein said low down force pressure is within the range of from about 0.10 psi to about 3.0 psi.

143. The apparatus of claim 142, wherein said low down force pressure is within the range of from about 0.10 psi to about 1.0 psi.